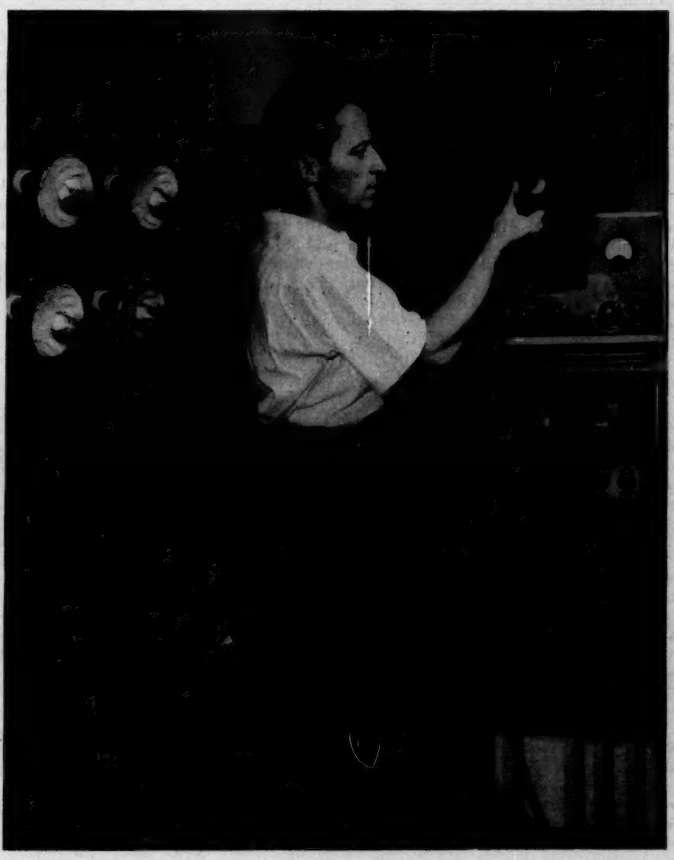
STATE ENGINEERING EXPERIMENT STATION

# The Research Engineer

GEORGIA INSTITUTE OF TECHNOLOGY

SEPTEMBER ATLANTA, GEORGIA 1951



# The Research Engineer

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Cover: Experimental Television Camera

## RESEARCH MANPOWER

A number of informed persons believe that there is not sufficient research capacity in the United States to serve normal civilian needs and also undertake all of the investigations required by the Armed Forces. Dr. Eric A. Walker, executive secretary of the Research and Development Board, Department of Defense, recently estimated that the country's research capacity does not now exceed $1.75 billion, of which at least 60 per cent is needed for military projects. This would limit civilian expenditures for research to about $700 million, as compared with approximately $780 million actually spent for this purpose in 1946 when the nation's research capacity was only $1.3 billion. With the Federal budget calling for government spending of $2.3-2.4 billion on research and development during the year begun on July

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Graduate education is as essential to research as research is to technological progress. Graduate programs provide both raw material and manpower for the prosecution of research. Students working for advanced degrees produce new concepts and fundamental data which serve as grist for the applied researchers' mills. At the same time, they learn the methods of research—those techniques which they will employ in later years to advance the frontier of scientific knowledge.

Today's complex technology puts a premium on the engineer whose training has equipped him to think and work on the level of the pure scientist. Unfortunately, while the demand for such men is high, the supply is limited. This is partly the result of an armed service deferment policy which makes little provision for graduate education. The principal reason is the basic shortage of men with sufficient mental capacity to take advantage of the opportunities for great service to society as well as satisfaction to themselves by engaging in research work. Not more than 10 per cent of our high school graduates have the mental capacity for this sort of work, and probably no more than one per cent have the temperament and character required. In this field, we face a definite shortage of "brain power."

Georgia Tech offers a fine opportunity for advanced study at the master's and doctoral levels. In addition to the laboratories of the various engineering schools, facilities of the Engineering Experiment Station are available for graduate instruction. Some students perform their thesis work on problems related to Station projects, and an increasing number find part-time employment at the Station. Contact with professional researchers and experience gained in attacking industrial research problems augment greatly their academic training. Georgia Tech's excellent relations with industry facilitate the scheduling of plant inspection trips and placement of the students, upon graduation, in jobs where their skills can most effectively be employed.

BLAKE R. VAN LEER,

*President, Georgia Institute of Technology*

# TELEVISION—PRODUCT OF RESEARCH

*By* M. A. HONNELL*

*In recognition of his research which led to the publication of several papers in the field of television, Martial A. Honnell recently received the 1951 First Faculty Award of the Georgia Tech Sigma Xi Club. As a part of this award, the winner is privileged to address the faculty and friends of Georgia Tech on a subject of his own choosing. Professor Honnell's choice "Television—Product of Research" will appeal to all who enjoy and marvel at this new contribution of research to our edification and entertainment.*

Few people realize that the new child of science, television, has been under development for more than a hundred years. The complete story of television would fill several volumes, for it is the story of many scientific developments combined in a deluxe medium of communication.

**Evolution of Television**

The early inventions which initiated research in television were concerned with the transmission and reception of pictures over telegraph lines. In 1842 Alexander Bain, an English physicist, first proposed a device to transmit pictures by electrical means. His equipment contained all of the basic elements of the modern facsimile systems. It is interesting to note that efforts to transmit pictures electrically were being made at the same time as attempts to transmit speech electrically.

The story of television is not complete unless mention is made of the element selenium, discovered by the Swedish chemist Berzelius in 1817. It was early found that a crystalline variety of selenium presented a high resistance to the passage of electricty, a property which made it suitable for use as a resistor in telegraph equipment. One afternoon in 1873, a Mr. May, the attendant

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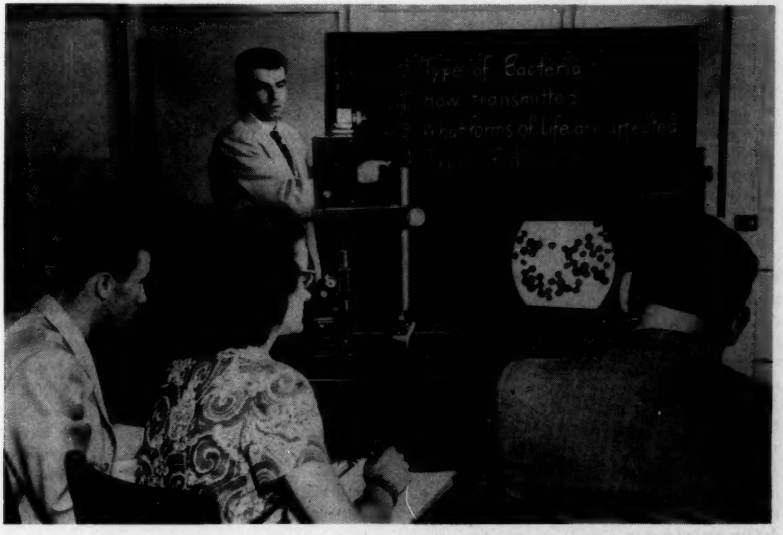


*Television has great potentialities for education. Here an RCA camera-receiver combination is combined with a microscope to show one slide of bacteria to a whole class.*

of the terminal station of the Atlantic Cable at Valentia, Ireland, noticed that his telegraph equipment was behaving in an erratic manner. He observed that sunlight shining on the selenium resistors caused the needle of the galvanometer to move. Further investigation of this effect by Willoughby Smith, an English physicist, showed that the resistance of selenium changed considerably on exposure to light.

Alexander Graham Bell, in his effort to develop an instrument to duplicate the performance of the human eye, was the first person to make practical application of this newly discovered property of selenium. Unfortunately, the response of selenium to changes in light is so sluggish that the early attempts to use a selenium cell as an electric eye for television were doomed to failure. Nevertheless, the discovery of this photoconductive effect was of great fundamental importance.

In 1887, Heinrich Hertz discovered what is known as the photoelectric effect. During the course of his classical experiments on electromagnetic waves, he found that the sparks set up by his apparatus passed more readily between two electrodes when they were illuminated by ultra-violet rays. This discovery led later investigators to the development of the photocell often referred to as the "electric eye." Although these photocells responded very rapidly to changes in illumination, they lacked the sensitivity required for the successful operation of the early television systems.

The minimum basic elements which constitute a television system are a light-sensitive pickup device, a communication channel and a picture-reproducing device. There is no unique solution to the problem of distant vision by electrical means. Many different techniques were thoroughly investigated before television reached its present state of development.

**Scanning Disc Experiments**

An invention which was destined to play an important role in the development of television was the scanning disc patented by Paul Nipkow in Germany in 1884. This device provided a simple means by which a scene could be explored point-by-point and the relative illumination of each point could be reproduced systematically at the receiver to reconstruct the original scene.

During 1925 John L. Baird in England and C. Francis Jenkins in the United States employed special forms of the scanning disc in the equipment which they used to give public demonstrations of successful television systems. The pictures reproduced by Jenkins were approximately two inches square and consisted of only 48 lines. These men deserve a great deal of credit for creating and maintaining public interest in television.

Baird was a very productive inventor of television devices. In 1928 he succeeded in transmitting television images in color by producing in rapid succession first a blue image, then a red, and then a green image. Although the results were crude, he demonstrated clearly the principles of color television. Baird also demonstrated three-dimensional, or stereoscopic, television for the first time in 1928.

**Modern Television**

In order to understand why the early television systems were unsuccessful, it is necessary to consider, briefly, the basic process by which a scene in motion is transmitted today. To provide the illusion of motion, a series of still pictures are shown in rapid succession at a rate of 30 complete pictures per second. Each of these pictures is divided into approximately 500 horizontal strips consisting of 600 small areas of varying light or shade similar to the dot structure in a half-tone engraving printed in a newspaper. An electrical signal proportional to these variations in shading is generated by a photosensitive device, the television camera tube, which generates the signal in an orderly sequence by scanning each of the 500 strips from left to right, one after the other, in 1/30 of a second. A simple calculation shows that approximately 4,000,000 cycles of information are transmitted in each second. This large number of cycles is necessary for high-quality image reproduction. Neither the scanning discs nor the radio systems of the 1920's were capable of meeting these requirements.

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# RECENT INDUSTRIAL APPLICATION OF THE LIQUID CYCLONE

*By* JOSEPH J. MODER, JR.*

*Cyclone separators have long been a favorite engineering tool for removing fine-particled solid contaminants from gaseous streams. Recently the basic principle, centrifugal force, has been applied to separations involving liquids and solids in equipment very similar to the familiar gas cyclone. This article discusses the design and operation of liquid cyclones and points out a number of their existing and potential applications.*

The separation of solid or liquid materials is a common step in the preparation of a wide variety of products, and the means for achieving this segregation are numerous. Some methods are of a general nature while others are highly specific, capitalizing on some particular chemical or physical property of the materials being separated. The sink-float method for materials of different specific gravities is a common example of the latter type. This process separates solids of different specific gravities by using liquids or heavy media slurries which float the lower specific gravity solids and sink the higher specific gravity solids. In a somewhat similar manner, solids having different settling characteristics due to size or shape factors and liquids of different specific gravities can be classified or separated.

A very high degree of separation is possible when sufficiently large gravity differences exist between the solids or liquids or when the solids are coarser than ¼ inch. However, high efficiencies are either unobtainable or uneconomical with less extreme conditions if only the force of gravity is employed in the separation process. The use of centrifugal force to improve efficiency and capacity by increasing the settling velocities of fine particles is possible, but in many cases it is too costly with mechanical centrifuges. In these cases the liquid cyclone has been utilized to effect a high quality and capacity separation at a very low cost.

### Description of the Liquid Cyclone

As can be seen in Figure 1, the liquid cyclone closely resembles the older, more familiar gas cyclone both in appearance and operation. The general flow pattern inside the cyclone is quite similar in appearance to the storm for which it is named. A mixture introduced tangentially into the cylindrical feed section assumes a rapidly swirling motion, the two exits causing the formation of a double vortex. The heavier portion of the feed is carried outward and downward

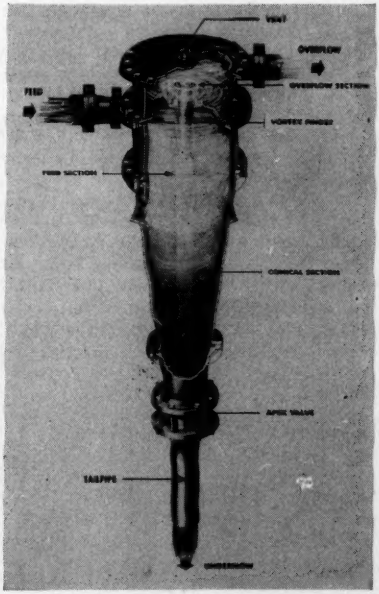


*Figure 1. Cut-away view of a liquid cyclone. Photo by courtesy of the Dorr Company.*

*Associate Professor of Industrial Engineering and Research Associate of the Engineering Experiment Station.

through the conical section by centrifugal force, exiting through the apex valve and the tailpipe. At the same time, the lighter portion, which forms the inner vortex, is forced upward through a centrally located tube called the "vortex finder" into the overflow section and out via the overflow pipe. Control of the internal flow pattern is a function of cyclone design, the dimensions of the inlet, overflow, and underflow nozzles being among the important factors, in addition to the inlet pressure head.

It has been estimated that the liquid cyclone is capable of creating a centrifugal force several thousand times that of the earth's gravitational force with capacities from 200 to 400 gallons per minute per square foot of cyclone cross-sectional area.

**Design of the Liquid Cyclone**

In order to determine the applicability of the liquid cyclone in effecting a given separation, it is necessary to have quantitative information as to the separation that can be expected as a function of the various design and operating variables. Once the applicability of the process has been established, additional data are required for calculating the number of stages of separation needed and determining how each stage should be designed and operated for maximum efficiency.

Numerous authors have attempted to provide the necessary fundamental data by mathematical analyses of the cyclone flow pattern and by tests of various liquid cyclones. Their results are useful qualitatively but are of limited value in actual cyclone design. Recently Dahlstrom[1,2] has published several papers containing quantitative information, and more recently a thesis by Moder[3] has extended this work.

Although the liquid cyclone is simple in appearance, a considerable number of design variables are involved in its construction. Among the more important are the dimensions of the three nozzles, the diameter of the cyclone cylinder, the included angle of the cone, the position of the overflow nozzle, the angle and placement of the inlet nozzle and the height of the cylindrical section. These factors were considered in detail and design recommendations were made in the references mentioned above.

For recommended designs quantitative empirical correlations have been developed which relate the solids classification size* or the per cent solids separation obtainable with the cyclone design and operating variables and with the properties of the materials being separated. Since liquid cyclones can be operated in series, without intermediate pumps if desired, literally any degree of separation can be obtained by use of a sufficient number of stages of separation. These correlations, then, make it possible to determine the applicability of the liquid cyclone in effecting a given separation and to calculate the number of stages of separation required.

**Use as Classifiers or Deslimers**

Depending on cyclone design and operation, the particle classification size can be varied from approximately 10 to 70 microns for the usual type of industrial slurry. Because of the uniformity and symmetry of the velocity gradients within the cyclone, a relatively sharp separation of particles is obtained. Practically all of the particles coarser than the classification size report to the underflow stream, while particles finer than the classification size exit in the overflow stream.

Cyclone separation can be applied to a surprisingly large number of problems, particularly in the mining industries. The desliming of coal, phosphate rock and sand are but a few of the applications of the liquid cyclone as a high-speed classifier. A simplified flow sheet of a typical classification operation is given in Figure 2. The feed for this process might be a wash-water stream in a coal tipple or one of the product-bearing streams in a sand or phosphate rock plant. The usual problem is to obtain the coarse solids (+200 mesh) in a dewatered state, relatively free of the finer-particle slimes. In this process, the feed stream is pumped into a desliming cyclone which is designed and operated to classify at approximately the 200-mesh point. As seen from Table I, test results for this op-

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**Classification size is the size of those particles which occur in equal amounts in the cyclone overflow and underflow streams.*

# THE STATE ENGINEERING EXPERIMENT STATION 1950 - 1951

*By* GERALD A. ROSSELOT* *and* FRED W. COX, JR.**

*For the Station fiscal 1950-51 was marked with record progress. Budget, staff and facilities all were expanded to meet the increased research and development needs of industry and government. The following condensation of the "Annual Report of the Director" summarizes the Station's activities during the year ended June 30 and indicates its status on that date.*

During the past fiscal year, the requirements of its sponsors on more than 104 active research projects called upon the Georgia Tech Engineering Experiment Station for significant increases in both its services and facilities. Marked expansions in research expenditures, staff and physical plant all contributed to make 1950-1951 the all-time record year. Research project budgets amounted to more than $840,000, a 40 per cent increase over 1949-1950, and 36 per cent above the previous high set in 1948-1949. This new level of research activity required the full-time employment of 186 persons and the part-time services of 80 others. This represents an increase of over 100 in the full-time staff while the part-time staff remains approximately the same. Completion of the new wing, begun in 1949-1950, doubled the floor area available in the Hinman Research Building. Floor space was also increased by remodeling and occupation of the remainder of Building No. 7 and the construction of new facilities at Research Area No. 2.

The increased activities of the Station have been the result of demands made on its facilities by both industrial and governmental resources. Several substantial gov-

*Director
**Assistant Director

*The floor area of the Station's main building has been doubled by completion of the new wing shown here extending from slightly right of center to the extreme left and into the left foreground.*

ernmental projects in the fields of electronics have developed from work carried out over the past several years. These were negotiated prior to the Korean crisis and involve long-term fundamental research in a field in which the Station's staff has developed special competence. In addition, the Station has undertaken several other projects pertinent to the national defense. These, however, constitute a relatively small part of the total activity. Efforts to expand our areas of industrial service are meeting with gratifying success. The many new industrial projects which were initiated during the year represent almost a 50 per cent increase over last year. Through them, the Station's contribution to improved technology and better products has been substantial.

The Georgia Tech Research Institute, which functions essentially as the contract section of the Station, has actively assisted our personnel in maintaining and expanding the Station's industrial contacts. In this connection, Captain DeWitt C. Redgrave, Jr., was recently appointed vice-president of the Research Institute. He is a graduate of the U. S. Naval Academy, holder of a Master's degree from Massachusetts Institute of Technology and former director of the Navy's Materiel Laboratory at New York.

For the first time in two years, substantial State funds are in sight for research purposes during fiscal 1951-52. It is planned to employ these funds to a large extent on projects of special significance to Georgia and to develop the Station's facilities for research in the interest of industry in the State.

## BUDGET

The expenditure of $840,000 for research operations during the past fiscal year constituted the largest volume of research in Station history. Of this, $799,400, or 95.2 per cent, was derived from research performed under contracts while 3.1 per cent was provided by endowments and special grants and 1.7 per cent by the Board of Regents.

Figure 1, which shows the sources of the Station's income from 1942 through 1951, is indicative of the growth in research volume over those years. In 1950-1951, $799,400

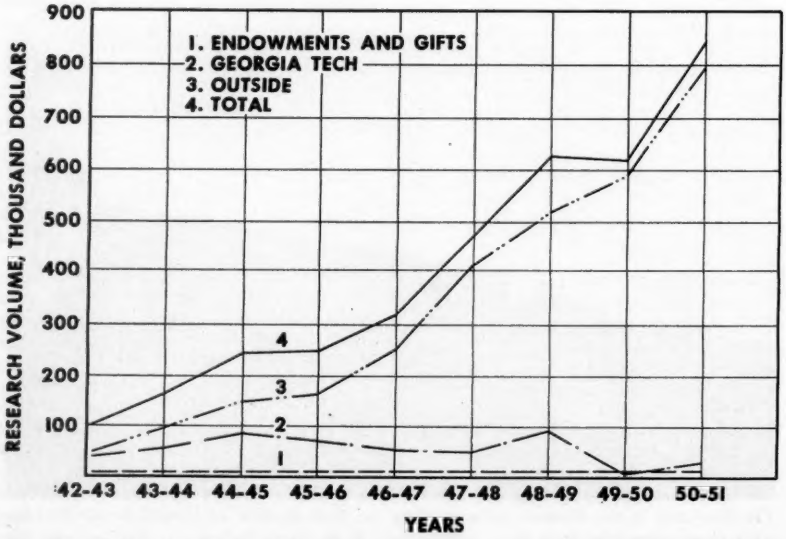



*Figure 1. Research volume of the Engineering Experiment Station, by sources of funds.*

came from research prosecuted for outside groups, $12,600 from endowments, $14,000 from the General Education Board and $14,000 from the Board of Regents.

### PERSONNEL

Perhaps the most important factor in the success of a research organization is the possession of an adequate and technically competent staff. The Station is proud of its many able technical people and the competence of its supporting staff of technicians, assistants and office workers. It is also indeed fortunate to be able to draw upon the capable faculty of the various Schools and Departments of the Georgia Institute of Technology for assistance and consultation as the need and desirability arise.

During the year, the Station's greatly increased research activities required the expansion of its full-time employment to 186 persons while its part-time employment remained rather constant at about 80 people. Of the total, 61 were faculty research associates; two, research professors; two, research associate professors; one, a research assistant professor; 25, research engineers; 50, research assistants; 67, technical assistants; and the balance, clerical and office personnel.

Even though the full-time staff has more than doubled, the supply of technically qualified personnel has lagged behind the demand created by the projects now in process and in prospect. At present the staff is being further strengthened to rectify this situation.

To succeed B. H. Weil, who resigned in October as head of the Technical Information Service, the Station was fortunate in obtaining John C. Lane, former head of the Information Service of the Institute of Gas Technology. Mr. Lane is a chemical engineering graduate of the University of Rochester and, like Mr. Weil, an experienced editor and technical writer.

During the year, the staff participated in the activities of numerous technical and scientific groups. A gratifyingly large number of the Staff have addressed technical and civic groups and many have presented papers or have published articles of a technical nature. The Director has served as chairman of two important off-campus organizations: the Engineering College Research Council and the Research Section, Engineering Division, of the Association of Land Grant Colleges and Universities. He has recently been elected a member of the National Research Council's Division of Engineering and Industrial Research. The Assistant Director, Dr. Cox, is now serving as the secretary-treasurer of the Southeastern Branch of the American Electroplaters Society and is chairman of the Herty Award Committee of the American Chemical Society. Dr. W. T. Ziegler is current chairman of the Georgia Section of the American Chemical Society; Mr. John C. Lane is editor of its monthly publication, *The Filter Press;* and Dr. R. S. Ingols is chairman of the Program Committee. Mr. W. J. Miller served as chairman of the local section of the Institute of Radio Engineers until January and is now chairman of its Arrangements Committee. Mr. H. P. Peters, currently secretary-treasurer of the Georgia Section, American Institute of Electrical Engineers, is also its chairman-elect. Dr. Ingols served as Georgia representative on the Board of Directors of the Federation of Sewage and Industrial Wastes Association. Mr. T. W. Kethley, past secretary-treasurer, is now vice-chairman of the Dixie Regional Section of the Institute of Food Technologists. Dr. Ziegler served as chairman of a Georgia Academy of Science committee to judge the papers submitted by state high school seniors in the National Science Talent Search. Mr. Lane is advertising manager of *Chemical Literature,* quarterly of the American Chemical Society's Chemical Literature Division. The list of professional, technical and business groups in which the Station is represented is too long to be included here. However, the foregoing clearly indicates that Station personnel have taken an active and leading part in the affairs of many outstanding regional and national organizations. This is of benefit to the men, to the Station and to the State, both from the prestige involved and, more important, from the qualities of leadership which such responsibilities bring out.

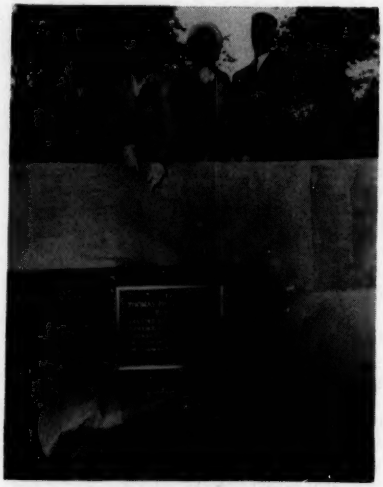
### FACILITIES

Completion and occupation of the new wing of the Station's main building con-

stituted the largest single addition to its facilities made during the year. Connecting the main building with the research annex, this wing adds 20,000 square feet to the 22,000 square feet of floor space previously available. On April 27, the entire building was dedicated as the Hinman Memorial Building in honor of the late Thomas P. Hinman whose estate contributed a substantial portion of the funds for the new wing. The remander was provided from the 1948-49 surplus funds of Georgia Institute of Technology, and the air-conditioning system was furnished by Georgia Tech Research Institute. The dedication program was impressive, with Dr. Eric A. Walker, Executive Secretary of the Research and Development Board, Department of Defense, presenting a major address at a luncheon prior to the dedication and later taking part in the formal ceremony with Dr. Harmon W. Caldwell, Chancellor of the University System of Georgia, Col. Blake R. Van Leer, President of Georgia Institute of Technology, Tech's Vice-President Cherry L. Emerson, Dr. Thad Morrison, Sr., General Chairman of the Hinman Clinic, and Dr. Hinman's three nieces, one of whom, Miss Dorothy Hinman, unveiled the plaque naming the building in her uncle's honor. The dedication ceremony was followed by an Open House in which the visitors inspected the building and viewed several special exhibits.

Another significant addition to the Station's facilities was expansion by about 40 per cent of the testing and laboratory space available at Research Area No. 2 on Atlantic Drive. This was provided by the U. S. Navy for use on two projects sponsored by the Bureau of Ships.

Notwithstanding the additional space provided by these fine new additions, the Station's expanded research program has made such huge demands on available facilities that its physical plant is, in many respects, now over-crowded beyond the point of effective performance. Additional laboratory facilities for approximately 100 technical people are urgently needed. In addition, shop facilities for 10-15 machinists and office space for about 10 supervisors and clerks are necessary. It would also be desirable to



*Three nieces and a grandnephew of Dr. Hinman were present at the dedication on April 27 to see the main building named in his honor.*

place the Photographic and Reproduction Service under one roof. For this purpose 3000-4000 square feet of floor space are needed.

Since by far the greater portion of the work in progress is being prosecuted for outside organizations, additions to Station owned equipment have been quite small as compared to those acquired for sponsored projects. However, a number of needed items have been purchased or constructed, and significant improvements have been made in the facilities of several laboratories.

Considerable progress has been made in equipping the X-ray laboratory for broad service to Southeastern industry. A special Station project initiated in January, 1951, has as its purpose the provision of suitable facilities for application of X-ray techniques to industrial problems such as the determination of crystal structure, the detection of flaws in metal castings and welds, the inspection of packaged goods, etc. For those industries, companies or individuals whose problems are too few to warrant establishment of their own X-ray laboratory, the

Station's facilities will fill a real need. In addition, the Station's experience will be made available to those companies which may, in the future, wish to set up their own laboratories.

In view of the fact that Georgia's peanut crop is second only to cotton as a producer of agricultural income, the Station's development of peanut cleaning and grading equipment is of major significance to our state. A pilot-scale air blast cleaner has been constructed and installed in the Red Diamond Mills at Cordele. This machine removes stones, sticks and other trash from stock peanuts and also separates undersized or damaged nuts from those which are suitable for marketing at optimum prices. Its cost is only about one-quarter that of existing machinery and its capacity is four times greater. A pilot-scale rotary disc sizer has been built and installed at the East Georgia Peanut Company in Statesboro. Capable of sizing a large volume of nuts without damage, its use to separate the roasting type from inferior grades is expected to increase markedly the volume and returns of the state's premium peanut business. Further testing and improvements of the V-corrugated slot screen have resulted in installation of a pilot-scale model in conjunction with the air blast cleaner at Cordele. A vacuum pick-out nozzle which promises to effect a 17 per cent saving in labor has been developed as an aid to the quality sorting of shelled peanuts. Work is continuing on the design and development of an electronic machine which will automatically perform the quality sorting operation. In addition to the specially built equipment just described, the Station's laboratory for peanut industry studies has added the following items by purchase: a peanut sheller, a stoner, weighing scales, an anemotherm and several grading screens.

The Micromeritics Laboratory (for the study of fine particles) has also undergone significant expansion during the past year. Perhaps most important has been development of the technique and equipment for rapid and reliable determination of surface area by the adsorption of surface-active agents. This method promises to be of value as a control and evaluation standard to numerous industries, particularly to the extensive clay and ceramic industries of Georgia. Specific items added to the laboratory during the past year include a Beckman spectrophotometer, a stirrer, a shaker, an analytical balance, a still and de-ionization column for water purification, an electrodialysis cell, an aerosol generator, a thermal precipitator, an improved ultrasonic sound generator, aerosol settling chambers, a Tyndall meter and a D.P.I. diffusion pump.

One of the Station's basic objectives is to provide the research services required by Georgia industries for the development and improvement of their products and processes. During the past year, the Applied Chemistry Laboratory was established to increase the Station's facilities for serving the state's smaller industries which do not maintain their own research staffs and equipment. A large room in the Hinman Memorial Building has been equipped with the necessary laboratory items and specialized apparatus built by our machine shop. In addition, many other types of special equipment have been made available through the cooperation of the various schools of Georgia Institute of Technology.

Useful additions have been made to the facilities of the Coatings Research Laboratory. A jar rolling mill was built in the machine shop for use in pebble milling and mixing of paints in closed containers. Georgia Tech's Hightower Textile School has made available a National X1A Weathering Unit for use in accelerated tests of paints, and a 45° test fence has been erected on the roof of the Hinman Memorial Building for exterior exposure evaluations. Other apparatus acquired for the study of protective coatings include a Baker Adjustable Film Applicator and a Sword Hardness Rocker. A file of current information on raw material, methods and equipment has been collected and continuously augmented. The work of this laboratory has considerable significance to the Georgia economy, since it is largely concentrated upon superior coatings for southern yellow pine.

Significantly improved utilization of existing facilities has been achieved by consolidation of the low-temperature microbiology and sanitary chemistry laboratories in one

large, well equipped work area. This has resulted in an exceptionally convenient arrangement for the pursuit of biological and biochemical investigations, both in regard to equipment and personnel. New additions to the low-temperature laboratory include an autoclave for steam sterilization and a specially designed chamber for sterilizing delicate materials with ethylene oxide. An ultraviolet attachment for the Beckman DU spectrophotometer has been purchased for use in the study of drinking water chlorination. Consolidation of these two laboratories has provided an excellent training facility for Georgia Tech students. As a service to the Georgia Tech educational program, it has been made available for such use.

### PUBLICATIONS

One measure of the progress of any scientific group is its contribution to the literature of its field. Quality as well as quantity must be considered in applying such an evaluation.

The quality of Station publications has been high, due primarily to careful preparation by authors experienced in their subject fields, but also due in part to the "quality control" functions performed by the Station's Technical Information Service. It is particularly gratifying that, for the fourth consecutive year, a paper published by a Station staff member, on work sponsored through the Station, has been awarded the Sigma Xi first prize for the best Georgia Tech research paper of the year.

Of the 33 publications produced by our staff during the year, two were printed as State Engineering Experiment Station Circulars, 15 as papers in the technical journals, 15 as articles in *The Research Engineer* and one as a paper in the fourth book of the American Chemical Society's Advances in Chemistry Series. Seven patent applications, some for the benefit of sponsors, others for the Station, were filed during the year.

The Station's bimonthly publication, *The Research Engineer,* entered its sixth year in May. Consistent with its established editorial policy, it has continued to report on Georgia Tech research and technical activities for the purpose of providing wider dissemination of such information and, thereby, of aiding in the development of Georgia and the South.

Assistance to two American Chemical Society publications has been rendered by the Station's Technical Information Service whose head serves as editor of *The Filter Press,* monthly bulletin of the Georgia Section, and as advertising manager of *Chemical Literature,* the quarterly of the national Society's Division of Chemical Literature.

### SERVICE ACTIVITIES

The Technical Information Service, the Mechanical and Engineering Design Services and the Photographic and Reproduction Service have each had to operate at record productivity to keep pace with the expanded research operations. Their assistance to the various divisions and projects has been an important factor in the over-all progress of the Station during the past year.

The Technical Information Service is now conducting two literature searches under contract: one, a "Monthly Summary of Industrial Developments" for nine large companies engaged in various petroleum processing activities; and the other, a newly initiated project which consists of supplying technical information to countries receiving Marshall Plan aid. The latter project is sponsored by the Office of Technical Services, U. S. Department of Commerce. Working in collaboration with the Photographic and Reproduction Laboratory, the Technical Information Service edited a series of motion picture sequences taken around the Station over a period of time into an integrated 25-minute film descriptive of the Station's activities. Together with a wire-recorded commentary prepared by the Service staff, this film was exhibited to a large number of visitors at the Station Open House following dedication of the new building on April 27.

The Mechanical and Engineering Design Services have provided indispensable aid to the various projects, primarily through their machine design and drafting functions. They have designed equipment, laboratory apparatus and instruments for the projects; have served in a consulting or advisory capacity to both the Station staff and outside sponsors; have prepared drawings and

diagrams for numerous reports, publications and patent applications; have aided in the drafting of several records of invention; and, in addition, have supervised the various Station buildings. The head of these Services has directed a number of the projects assigned to the Mechanical Sciences Division during the past year. In part, these included development of a new type of hydraulic weighing scale, design and construction of a semi-automatic device for preparing and sectioning watermelon rinds prior to pickling, design and testing of a remote-indicating low pressure alarm for truck tires, mechanical evaluation of aluminum double-hung windows, conversion of standard garden tractors to pasture clippers and development of a cleaner for soft drink bottles.

The Photographic and Reproduction Service has repeatedly assisted project personnel in the solution of problems involving the use of photography, and it has participated actively in projects requiring the use of high-speed motion picture photography to study the action of machine parts. By far the majority of the illustrations appearing in the *The Research Engineer* are prepared by the "Photo Lab" which, in addition to photographs, supplies excellent line drawings, diagrams, charts and similar material.

## RESEARCH OPERATIONS

Of the 104 projects conducted during the year, 46 were classified as major, since they involved extensive research programs, while 58 were classified as minor because they could be completed in a relatively short time. Twenty major projects and 35 minor projects were initiated during the year, exceeding by 61 percent and 3 per cent, respectively, the numbers of major and minor projects inaugurated in 1949-50.

Six projects were sponsored entirely by the Station and three were jointly sponsored by the Station and cooperating government agencies. Our dependence upon outside sources for research income during the past year is strikingly illustrated by the fact that 95 projects emanated from outside—31 from government and 64 from industry—as contrasted with only 9 in which Station funds were used even in part. Of the industry-sponsored projects, 38 were conducted for private companies, while 26 were prosecuted for associations or individuals, including several men who hoped to develop commercial applications of ideas submitted for study.

Since 1949-1950, the Station's research operations have been organized into three cooperating divisions: Chemical Sciences, Physics and Mechanical Sciences. Each has as a major purpose the strengthening of the Station's facilities and staff for research in its own general field. New projects are assigned to the division under which the major portion of the work will be conducted, and the other divisions render assistance as required. By this arrangement, administration and supervision of each project are centralized in one division, while the complete facilities and abilities of the Station are available for use in its prosecution.

Brief summaries of a number of the projects which the Station carried on during 1950-51 are presented below to indicate the nature and scope of the work of the three Station divisions. Security requirements prevent description of some very significant research, and many of the industrial projects cannot be discussed out of respect for the confidence in which they were conducted for their sponsors.

## CHEMICAL SCIENCES DIVISION

**Very Low Temperature Research—Project 116.** Sponsored by the Office of Naval Research, this project has for its objective the investigation of the electrical and magnetic properties of substances at very low temperatures (1.5-20°K) with emphasis on the discovery of new superconducting materials. During the year, the work has been continued using a magnetic method for superconductivity measurements. Among the substances tested were: the carbides of titanium, vanadium, zirconium, tantalum and tungsten; the borides of columbium, tantalum and zirconium; the nitrides of lanthanum and cerium; and lanthanum hydride. None exhibited superconductivity down to 1.8°K, although other investigators, using electrical resistance measurements, had reported the occurrence of this phenomenon in three of them at somewhat higher temperatures. The preparation and properties, including crystal structure, of lanthanum

hydride and nitride have been studied in some detail. Further work on the nitrides and hydrides of the cerium group metals is planned. Mr. R. A. Young's thesis for his Master's degree covered "The Crystal Structure and Superconductivity of Lanthanum Nitride."

Research on the separation of the cerium rare earths by means of ion-exchange techniques has resulted in methods for analyzing lanthanum-rich mixtures containing about 1.5 per cent cerium, praseodymium and neodymium and similar mixtures in which cerium is the major constituent. Mr. F. W. Lafond completed his Master's thesis on "The Separation of Neodymium and Praseodymium by Ion Exchange. II. The Effect of pH of Eluent on the Elution of Neodymium and Praseodymium."

**Fine Particles Research—Projects 143, 161, 181, M-169, M-95 and M-187.** The staff and facilities of the Micromeritics Laboratory have been engaged in investigations for five sponsors on six contracts.

Projects 143 and 181 for the Signal Corps have been concerned with the study of existing and proposed methods for determining the characteristics of fine particles. Work to date has been concerned primarily with methods for surface area and particle size measurement, since these parameters are common to all powdered materials and independent of other properties such as chemical composition, density, etc. It has been concluded that the gas adsorption method (BET) may be taken as a standard for surface area determination. However, a new and much more rapid method, involving adsorption of a surface-active agent, such as a fatty acid, has been found equally reliable for nonporous and certain porous materials. This method, developed during the study, promises to be of value as a control and evaluation standard to numerous industries, particularly the extensive clay and ceramics industries of Georgia.

Project 161, sponsored by the Chemical Corps, has as its objective study of the factors which affect the aggregation of an aerosol, particularly electrical charge, concentration and the nature of the gaseous suspending medium.

Projects 95, M-169 and M-187 involved determination of particle-size distribution and/or surface area of various materials submitted by industrial sponsors.

In addition to the work for sponsors, four graduate theses and numerous undergraduate special problem studies have been conducted.

**Vegetable Oil Studies—Project 87.** The Station-developed process for simultaneous extraction of oil and protein from various oilseeds by water grinding and centrifuging has undergone further study during the past year. A patent application has been filed covering the process and the required emulsion-breaking procedure. Tung meal prepared by this process was subjected to chick feeding tests, and the results indicated the possibility of upgrading the by-products of tung oil extraction by use of the Station process.

It was found that oven drying of tung materials led to erratic oil content analyses, probably because of the polymerization of tung oil at the temperatures employed. A method of removing water by azeotropic distillation with benzene and heptane was found effective.

Experiments demonstrated that almost 100 per cent shell-free tung kernels can be obtained by a combination of impact shelling and sink-or-float separation. It is believed that a commercial apparatus could readily be designed to employ these principles.

## FOOD RESEARCH

**Effect of Low Temperatures on Microorganisms—Projects 150, 153 and 179.** Since Projects 150, 153 and 179 all relate to the preservation of food by freezing, they will be discussed as an entity here, although the funds for Project 150 were supplied by the Station and the other two projects were sponsored by the National Institutes of Health. During the year, the work was directed toward study of the effects of low temperatures and rates of cooling and thawing upon microorganisms in an effort to determine the viability of pathogens in frozen foods under various conditions. The results to date have emphasized the complex nature of bacteria response to temperatures below 0° C. Among the many variables

affecting bacteria survival are: the presence or absence of ice in the environment; salt, sugar or protein concentration; acidity or alkalinity; and the prior history and condition of the bacteria. The results of these investigations are expected to be of value in predicting the conditions under which microorganisms can best be controlled in frozen foods and in extending the basic information on the effect of low temperatures on living cells.

**Increasing Shelf Life of Potato Chips—Project 145.** The main purpose of this project, sponsored by Gordon Foods, Inc., was to increase the shelf storage life of potato chips in hot weather and to minimize the financial loss incurred through rancidity. The problem has been solved by the development of a silica gel-activated carbon packet inserted in the bag. This keeps the chips fresh and crisp for weeks under hot and humid weather conditions. The sponsor, who previously lost thousands of dollars per month through shelf spoilage, is now using protective packets in the entire output of his plants in Atlanta, Jacksonville, Louisville and Cincinnati. An article describing the results of this research was published in *Food Engineering* for July, 1951.

### COATINGS RESEARCH

**Physical Studies of Exterior Paint Systems Applied to Southern Yellow Pine—Project 149.** This project, jointly sponsored by the Station and the Southern Paint and Varnish Production Club, has for its objective the improvement of paint durability and appearance on southern yellow pine. This objective is being pursued by evaluating the effects of formulation and application procedures through exposure tests under controlled conditions. In July and August, 1950, 172 paint panels were placed on exterior test-fence exposure, and during the summer of 1951 about one-half as many more will be placed on exposure. The panels will require three or more years of weathering before completion of the program.

### BIOCHEMICAL RESEARCH

**Development of Microbiological Section—Project 174.** Recognizing the importance of microbiological research to the public health and the national defense, the Station has set up Project 174 specifically for the development of a facility for such research. The low-temperature microbiology laboratory and the sanitary chemistry laboratory have been consolidated in one large, well equipped work area. This has resulted in an exceptionally convenient arrangement for the pursuit of biological and biochemical investigations, both as regards equipment and personnel. It has also provided a valuable facility for use in the instruction of Georgia Tech students, and it is being so employed.

**Chlorination of Amino Acids—Project 166.** This project, sponsored by the National Institutes of Health, has been established to study the reactions of chlorine with organic compounds, such as the amino acids, which are found in surface waters. The ultimate goal is development of a technique for reducing the taste of chlorinated water, thereby providing the consumer with more palatable but no less safe drinking water. The initial phase of the project has been devoted to the establishment of procedures for identifying the intermediate and end products of chlorination. From the identity of the chlorination products it is believed that the nature of the chemical reactions which take place may be determined. Also it will be possible to determine the minimum concentrations of the various products which result in unpleasant taste.

*Projects 150, 153* and *179*, reported under Food Research, are other biochemical studies being carried out by the Station.

### TEXTILE RESEARCH

**Parachute Fabric Studies—Project 170.** The initial objective of this project, which is sponsored by the Air Materiel Command, is to study the permeability to air flow of a number of potential parachute fabrics. Data are sought which will provide the necessary information for establishing a permeability-deformation interrelation for correlating the performance of parachute fabrics.

**Physical Study of Yarns—Project 156.** This project, also for the Air Materiel Com-

mand, is concerned with determination of the effect of twist on the properties of synthetic yarns such as nylon, rayon, Orlon and vinyon. Intended to provide a better understanding of parachute fabrics, its results will also be useful to yarn manufacturers and textile mills.

### WOOD RESEARCH

**Wood Distillation—Project 146.** Financed by a Georgia Tech Research Institute fund for fundamental research, this project has demonstrated the applicability of the fluidized powder technique to a distillation process for the production of wood chemicals. Sound data indicate that the Georgia Tech process can be used to distill wood at high rates without sacrifice in the yields of valuable chemicals. The work has been reported in a thesis submitted in partial fulfillment of the requirements for a Master of Science degree in chemical engineering. It also was the subject of an article in the May, 1951, issue of *The Research Engineer*.

### RAW MATERIAL SURVEY

**Industrial Needs for Raw Materials of Plant Origin—Project 177.** A survey of industrial needs for raw materials of plant origin is being conducted for the Bureau of Plant Industry, U. S. Department of Agriculture. The information obtained will be used to guide the sponsor in foreign exploration for plants to be introduced in American farming. The economic and industrial potential of this project is great, and it seems likely that it will also prove of value to the national defense by indicating possible sources of strategic materials or acceptable substitutes for such materials.

## PHYSICS DIVISION

Since most of the research being conducted by the Physics Division carries some form of security classification, it is not possible to describe many of the projects in very informative detail, and it would not be discreet even to mention the titles of several. However, it can be said that the personnel of this Division has grown from about 30 last year to approximately 90 at present, and expansion to a staff of some 120 probably will be required to handle the work in hand and anticipated during the near future.

### ELECTRONICS RESEARCH

**Radar Research—Projects 157, 162, 172, 175 and 178.** Project 157 for the Bureau of Ships is concerned with the study of certain natural phenomena in the radar field and with the eventual development of suitable radar systems to accomplish the objectives stated in the contract. Project 162 involves research for the Air Materiel Command on the development of a new type of radar device. Project 172, sponsored by the Bureau of Ordnance, U. S. Navy Department, consists of both theoretical and experimental investigations of problems in the radar tracking and missile guidance fields. Project 175 for the Signal Corps has as its purpose elimination of power losses in a special radar antenna so that such units may be used in tactical radar equipment. Project 178, supported by the Bureau of Ordnance, U. S. Navy Department, through the Research and Development Board, is in the general field of radar reflection characteristics. It involves the preparation of an annotated bibliography covering a broad field and, ultimately, the preparation of a classified book for use by the Armed Services and related research groups.

**Propagation Studies of Electromagnetic Waves—Project 109.** The experimental phases of this project for the Air Materiel Command, as described in the preceding Annual Report, were completed prior to the beginning of the 1950-51 fiscal year. Its primary objective was determination of the effects of atmospheric conditions and various weather phenomena on the propagation of microwaves over land paths of the type existing in the hills of northern Georgia. The ultimate goal was the selection of an optimum frequency (or frequencies) for a microwave relay system which would provide reliable communication and video operation over rough terrain at distances of 20-50 miles. Activities last year were devoted to a detailed analysis and interpretation of the experimental data and to the preparation of a series of reports describing equipment developments, techniques employed and results of the propagation measurements.

**High Frequency Crystal-Controlled Oscil-**

**lator Circuits—Projects 131 and 171.** Project 131 for the Signal Corps has as its objective the development of crystal-controlled oscillators capable of performance at very high frequencies. Project 171 is a logical continuation of 131, but with emphasis placed on resonators other than quartz.

**Television Research—Project 164.** The 1950-51 objective of this Station-sponsored project was to develop a simple telemetering system for transmitting several channels of information over a communication system. Such a system has been constructed, and preliminary analysis of its performance indicates that it offers a simple and reliable means of accomplishing the objective.

### POWER TRANSMISSION

**A-C Network Analyzer—Project 126.** During the year, the A-C Network Analyzer was used continuously in commercial work with the exception of four weeks, three of which were not scheduled because of holidays. This usage exceeded anticipation and probably came about because of accelerated power system expansion to meet defense power requirements. Two Georgia Tech students holding Westinghouse Fellowships gained valuable experience through employment in the A-C Network Analyzer Laboratory.

### ELECTRON MICROSCOPE STUDIES

**Miscellaneous Studies — Projects M-95, M-149, M-182, M-190 and 89J.** The object of Project M-95 was to provide electron micrographs of submitted samples, mostly clays. A joint paper by Mr. S. C. Lyons of the Georgia Kaolin Company and Mr. L. A. Woodward, project director, was presented at a meeting of the Technical Association of the Pulp and Paper Industries in Boston. This paper covers a theory of the gloss development mechanism based on data obtained from the project work. Project M-149 for Vanderbilt University consisted of making calibrated electron micrographs of colloidal gold particles. These were used by the sponsor in the calibration of very small openings in silver membranes which had pore sizes in the ultrafilter range. A graded gold sol was arranged so that some of the particles could pass through the membrane, and the smallest size that did not go through was considered about the size of the openings. Project M-182 for Emory University involved taking electron micrographs of dextran molecules. Project M-190 consisted of electron microscope studies of clay samples. The object of Project 89-J was to take electron micrographs of manganese dioxide and other materials. During the year, micrographs have been made of manganese oxide, certain iron oxide pigments, tri-basic copper sulfate and other minerals. In addition, X-ray and electron diffraction plates have been made for most of these materials to determine their structure.

### MISCELLANEOUS STATION PROJECTS

**X-Ray Laboratory—Project M-184.** This project has been initiated to set up a laboratory with full facilities for all of the applications of X-rays from the determination of new crystal structures through X-ray spectroscopy to radiography. This laboratory will be used in the solution of problems of the industries of Georgia and the surrounding area.

**Study of Graphical Methods of Computation—Project 181.** The principle objective of this project during the past year has been completion of certain theoretical phases of nomography having to do with the design of two-dimensional and three-dimensional nomographs. This phase is now completed and several articles describing it have been published. The next phase is simplification of nomograph construction, and progress is being made despite a shortage of funds for the design and construction of the necessary mechanical scaling devices.

## MECHANICAL SCIENCES DIVISION

### PEANUT INDUSTRY RESEARCH

**Sampling, Cleaning, Handling and Shelling of Peanuts—Projects 147 and M-167.** Project 147, conducted jointly by the Station and the Georgia Experiment Station under the sponsorship of the Georgia-Florida-Alabama Peanut Association, has had as its primary objective the development of high capacity cleaning equipment and other machinery which will reduce the cost of proc-

essing peanuts. Tests on the pilot-scale air blast cleaner installed in the Red Diamond Mills at Cordele have shown that it has many uses, such as threshing stock peanuts, precleaning them prior to sale, and cleaning and separating in shelling plants. The initial cost of the machine is only one-quarter that of existing machinery, and its capacity is four times as great. Related to the main study, Project M-167 consisted of construction and installation of a pilot-scale rotary disc sizer at the East Georgia Peanut Company, Statesboro. This machine is capable of sizing a large volume of peanuts without damage to the product, and its use to separate the jumbo roasting type should prove economically beneficial to the peanut industry. Other accomplishments of Project 147 include development of a semi-automatic vacuum pick-out nozzle which reduces labor about 17 per cent and design of an electronic sorting machine which will automatically perform the quality sorting operation.

**Industrial Engineering Survey of Peanut Shelling Industry—Project 168.** The purpose of this Station-Georgia Experiment Station project is to study the peanut shelling industry from an industrial engineering viewpoint to determine steps which should be susceptible to improvement. The results to date are promising and should prove of value to the shelling industry.

### AERONAUTICAL RESEARCH

**Helicopter Development Program—Project 41.** During the year, an analysis was made of the dynamics of the counter-rotating, rigid-rotor configuration which has many theoretical advantages. This analysis disclosed the reason for the instability experienced with every helicopter that has employed this configuration. A mechanical method of eliminating this instability has been devised, and further consideration is being given to the problem of stabilization.

**Effect of Twist and Taper of Helicopter Rotor Blades in Vertical Descent—Project 127.** The work on this project for the National Advisory Committee on Aeronautics has been reported to the NACA, suggested changes have been made and the revised version will soon be published by the NACA.

**Helicopter Rotor Theory—Project 159.** This project for the NACA sought to eliminate the small-angle approximations commonly used in rotor theory. This was accomplished; and, in addition, a way was found to handle the exact blade chord and twist distribution by means of certain solidity functions. Use of these functions, along with a new treatment of profile drag terms greatly reduced the number of terms in the final equations and considerably increased their utility.

### HYDRAULICS RESEARCH

**The Flow of Water Through Open-Channel Constrictions—Project 173.** This project, sponsored by the Surface Waters Branch of the U. S. Geological Survey, involves development of the fundamental background for application to the following practical problems: (1) determination of fluid flow in the vicinity of bridge and culvert openings; (2) design of such openings to provide for predetermined discharge capacities; and (3) determination of the "backwater effect" in rivers due to bridges, culverts and connecting embankments. The work to date has placed emphasis on the phenomena associated with the flow of water through a simple open-channel constriction. An existing flume in the Hydraulics Laboratory has been modified for use in this study.

### MECHANICAL ENGINEERING RESEARCH

**Device for Preparing and Sectioning Watermelon Rinds—Project 176.** The objective of this project for the Georgia Experiment Station was to develop a rapid method for removing the center meat and outer green skin from watermelon rinds and to cut them into small sections suitable for pickling. A semi-automatic method was developed.

## TELEVISION

*Continued from Page 4*

That these limitations were generally recognized at the time is shown by the following quotation taken from A. Dinsdale's book

*First Principles of Television* published in 1932: "During the last few years those interested in the exploitation of television have been responsible, both in Europe and America, for the release in newspapers and magazines of a flood of publicity designed to convince the public that 'television is here,' or 'just around the corner.' As one result, potential purchasers of wireless sets have postponed their purchases until such time as they can buy the long-promised set which will also incorporate television. This has caused grave concern to the radio manufacturers' associations of both Great Britain and America. Both groups have been moved to discourage television demonstrations and exhibits at their annual radio exhibitions, and the American association has even gone so far as to issue counter publicity denying that television is anywhere near ready for public consumption."

In the issue of the *New York Sun* for August 2, 1930, a writer by the name of R. P. Clarkson wrote, "We have no television in the home and we are nowhere near having any. . . . If television is ever developed along present lines, I'll eat three scanning discs and a couple of kino lamps." These statements have been quoted because they resemble so closely the present opinion concerning color television.

**Development of Present System**

The proposals which have been most fundamental to the development of a practical television system were made in 1907 by Boris Rosing, a Russian college professor, and in 1908 by Campbell Swinton, an Englishman. Rosing suggested the use of a cathode-ray tube as a viewing device. Campbell Swinton is credited with making the first proposal for an electronic camera tube. These suggestions could not be put into practice until ensuing basic research in electron tubes made them physically realizable.

All-electronic television had to wait until 1923 when Dr. Vladimir Zworykin, who was working for Westinghouse at the time, filed a patent application on a new camera tube which he named an "iconoscope." Several years later he developed a cathode-ray tube to receive television images and called it a "kinescope." Another inventor, Philo T. Farnsworth, developed a camera tube called the "image dissector," which contained an important new type of amplifier, the secondary electron multiplier.

The Radio Corporation of America was quick to realize that the iconoscope and the kinescope would eventually result in a successful television system. By 1940, RCA had invested more than $10,000,000 in television research, development, experimentation, patents, field tests and program service. It was in 1941 that NBC's television station WNBT went on the air as the first commercially licensed television station in the United States. Over a hundred years had passed since Alexander Bain's first experiments with the electrical transmission of pictures!

The average person who reads the newspapers is quite well informed about the present status of entertainment television. Recent figures projected to June, 1951, reveal that there are now a total of 107 television stations serving a total of 26,000,000 families who own 12,000,000 television sets. It is stated that the average saturation of the potential television audience in the present television broadcasting centers is 48 per cent.

A new industry like television will inevitably bolster the economy of the nation. The retail value of the 7,000,000 television receivers sold in 1950 was over $2,000,000,000. An expanding receiver market will be available when the Federal Communications Commission lifts the present ban on new television stations. Great sums of money are being spent on new coaxial cable and microwave link installations which are destined to interconnect all major population centers of the country in the near future. Electric utilities also stand to gain from the television boom. It has been estimated that each television set represents an average increase in consumer load of 200 watts. For the present total of 12,000,000 television receivers, this represents a 2,400,000 kilowatt load of excellent power factor to the electric power industry.

**Future Developments**

It will be many years, however, before continents will be interconnected with television program circuits. Few people realize that the Atlantic Cable connecting New York with London cannot be used to trans-

mit ordinary speech. Special amplifiers and techniques are in the process of development which will someday eliminate this limitation. At present, when a person in New York telephones a person in London, the conversation goes over a special radio circuit. An international television program service is dependent on research yet to come.

Color television is no longer "just around the corner." Successful color television equipment has been manufactured for industrial use, where the legal restrictions of the FCC do not apply. This equipment, employing the CBS revolving color disc, produces highly satisfactory color images, and it is the simplest technique available at present.

Why, then, the current legal battle over color systems? The opposition to the CBS color system is based on several logical factors. The most important of these is that the present owners of television sets will be unable to receive the CBS color pictures in black and white because of technical limitations which forced CBS to use incompatible frame and line frequency standards. Another reason for the opposition is the belief that the quality of pictures produced by an electronic color system will continue to improve as new developments are made, while any outstanding improvement of the color disc system is unlikely. It is important to note that colored movies originally started with revolving discs and made little progress. Television progress remained at a standstill until the industry divested itself of the whirling disc.

The present battle over color television has resulted in a great acceleration in research directed toward an all-electronic color system. Significant progress has been made in color television tubes and receivers. The all-electronic color television camera is still, however, a bulky and complex device requiring three camera tubes and a critical optical system. The proposed electronic color systems will produce black-and-white images of present quality on standard television receivers.

In view of the fact that the Supreme Court has decided in favor of the FCC decision approving the CBS color system, color receivers will presumably be made available to the public as rapidly as the international situation permits. The majority opinion in all branches of the television industry is that the FCC decision is both unfortunate and premature. The net effect of this decision is that the public is saddled with an inferior set of color picture standards which provide less fine detail than is now available in the present black-and-white pictures.

There are good reasons to believe that future CBS color receivers will utilize a tricolor cathode-ray tube of the type developed by RCA in order to avoid the disadvantages of the color disc. There is no way, however, of increasing the amount of picture detail presented in the vertical direction since this is standardized at 405 lines for the CBS color system, as compared to 525 lines for black-and-white pictures.

The case for all-electronic color television is not completely hopeless. The FCC has indicated that it will approve an all-electronic, compatible color system when a manufacturer demonstrates a reliable receiver that can be sold to the public at a reasonable price.

There need be no fear that present television receivers will become obsolete in the near future. The "forgotten man" in the color dispute is the daring color broadcaster employing an incompatible system. How can he sell a color program to an advertiser in an area where the majority of the receivers cannot receive the pictures in black and white? It is the broadcaster who should have a compatible color system if color television is to meet with wide acceptance.

**Specialized Developments**

The story of television should also include the story of the development of sound motion pictures, of microwave links, of the coaxial cable and of radio broadcasting. Television is the all-inclusive medium of communication which combines important features of all of these systems. Entertainment television, however, will prove to be only one of the many important applications of television in the future. Television research has made many contributions to other fields.

The rapid development of radar was due in a large measure to the store of knowledge which had been accumulated as a result of

research in television. The parallel research in the field of still-picture transmission led to successful commercial wire and radio-photo transmission services in the early 1920's. Other inventions which resulted from research in television are the electron microscope and the infra-red camera tube which was used extensively for night vision during World War II. This tube, mounted on an Army rifle, is generally known as a "Sniperscope." A scene illuminated by invisible infra-red light is converted to a visible image by the tube, thus enabling soldiers to aim accurately at targets in pitch-black darkness. More recent developments which stem from the television camera tube are "memory" tubes which can store images, or other information, for comparatively long periods.

Westinghouse has demonstrated an X-ray fluorescent image amplifier similar to the infra-red camera tube. This tube, called the "Fluoricon," produces a hundred-fold brightness amplification of fluoroscopic images. Recent research at Johns Hopkins was directed toward the development of a television system for viewing fluoroscopic images. Several advantages over direct viewing of fluoroscopes are immediately apparent. A television system is capable of increasing the contrast and of giving a brightness amplification of the light emanating from the fluoroscope. Furthermore, one or more persons may view the image on the television monitor in complete safety. Television may soon open up a new field of stereoscopic fluoroscopy, providing three-dimensional views of moving X-ray images.

Several compact, reliable television systems are already available for industrial use. One of these has a camera which is approximately the size of a 16-mm movie camera, and the monitor containing the necessary additional equipment is the size of an average suitcase. There are boundless potential applications of these closed-circuit television systems.

A complete portable back-pack television transmitter weighing 53 pounds was recently demonstrated by RCA. A single battery operates the equipment for 1½ hours. A two-way circuit permits the cameraman to communicate with the receiving control station. The antenna is mounted on the back-pack, and a small kinescope built into the miniature camera serves as a view-finder for the cameraman. Numerous applications are foreseen for this television transmitter with its useful range of one mile. It is suitable for the transmission of news pictures and commentary directly to newspaper editorial offices, and it has many industrial and military applications.

Research is continuing to produce many needed improvements in television equipment. The large, glareless, high-contrast television tubes used in the newer sets are the result of recent research. Improvements in receiver circuits have produced clearer and more stable pictures. Although many new receiving antennas are on the market, there is a need for a compact and efficient television receiving antenna which will harmonize with the architecture of the average home.

An interesting aspect of research is that developments which prove to be useless are often resurrected many years later when new knowledge, or a new approach, shows that the original ideas have merit. Several old fundamental principles are now under investigation in connection with research on projection television and color television. These are the electro-optic and magneto-optic effects. Electric and magnetic fields are used to control the magnitude and color of polarized light transmitted by certain crystalline substances. Many new applications of other well-known principles are sure to enlarge the field of television in the near future.

A consideration of the psychological factors which affect television picture perception will result in improved picture fidelity. It should be remembered that what the observer sees on a television screen is a grand illusion which depends on the persistence of both vision and the image on the fluorescent screen in order to produce an apparently moving image. What is actually transpiring on the screen of the picture tube is that a small spot of light, of rapidly varying intensity, is moving from left to right at a speed of 3 miles a second and is moving downward at a speed of 30 miles

an hour. The observer supplies the illusion of continuity of motion, of size and of depth out of his own experience. The techniques employed in the electronic color television systems proposed by General Electric and RCA are based on important principles governing the physiological response of the human eye to color stimuli.

* * * *

Whenever a major scientific development with the social significance of television is placed in the hands of the public, there usually develops an immediate opposition by those who fear that the status quo will be upset. There is no doubt that the radio broadcasting and the motion picture industries will undergo major changes as a direct result of television. Either directly, or indirectly through advertising and educational programs, television will affect our mode of living. The interpretation of the effect of television on society depends in a large measure upon individual attitudes. It will require continuing research to determine the true impact on society of this medium of communication which brings into your living room a combination of the theatre, the motion picture, the radio, the newspaper and the magazine.

## APPLICATION OF THE LIQUID CYCLONE

*Continued from Page 6*

eration indicate that approximately 97 per cent of the desired +200-mesh material is recovered in the desliming-cyclone underflow stream at a solids concentration of about 70 percent for sand and phosphate rock and 50 percent for coal, a less dense material. The data also indicate that more than 90 percent of the undesired finer material is eliminated in the cyclone overflow stream. As indicated in Figure 2, the overflow stream is reworked in a "high-efficiency" cyclone which will eliminate particles down to about the 10-micron size. In some cases this cyclone will produce an overflow stream which can be reused in the process together with a small amount of fresh water make-up. This reduces or eliminates the need for large settling ponds, a serious problem in many industrial plants today due to the present trend in stream-pollution legislation.

The high-efficiency cyclone in Figure 2 can be replaced by a second desliming cyclone to increase the product recovery, should the value of the material warrant such an operation. The second desliming cyclone, designed and operated in the same manner as the first, will have approximately the same percentage recovery of the +200-mesh material as before; i.e., 97 percent. Thus, two desliming cyclones in series will yield an over-all recovery of the +200-mesh material of $97 + (97 \times .03) = 99.9$ per cent.

To those familiar with classification equipment, the data of Table I show a striking improvement over conventional equipment in both capacity and recovery.

**Separation of Close Gravity Solids**

In several instances, the liquid-solid cyclone has been used in the separation of

TABLE I. CLASSIFICATION TEST RESULTS

| Material | Feed % Solids | Underflow % Solids | Overflow % Solids | Underflow +200-Mesh Recovery | Overflow −200-Mesh Elimination | Feed Solids T/hr. | Feed Slurry 6 PM | Cyclone Diameter (in.) |
|---|---|---|---|---|---|---|---|---|
| Phosphate Rock* | 14.2 | 72.8 | 1.5 | 96.8 | 90.6 | 33.8 | —— | 24 |
| Sand | 10.2 | 71.0 | 3.0 | 97.6 | 92.8 | 29.0 | 1300 | 34 |
| Coal | 14.3 | 52.5 | 6.4 | 96.2 | 88.0 | 1.8 | 49 | 9 |

*Presented before the Mineral Beneficiation Division of AIME at St. Louis, Mo., Feb. 19, 1951 by Frank T. Weems.

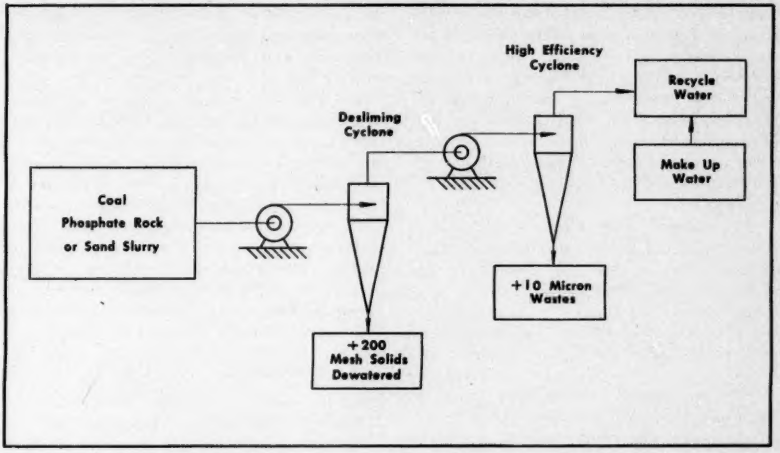



*Figure 2. Simplified flow sheet of a typical classification operation.*

close-gravity, solid agricultural products, and there are indications that many more such applications exist. The usual problem consists of separating different types of seeds which are harvested as a mixture or of recovering seed from a seed-chaff mixture. Many devices for making such separations capitalize on the electrical, surface or density properties of the materials being separated. However, in many cases their efficiency and capacity are low, and the cost, consequently, is high. Use of the liquid cyclone, together with a liquid whose specific gravity is between that of the materials to be separated, can circumvent these difficulties in many cases. Here the materials to be separated plus the recycle are fed into the primary cyclone. The overflow stream of this cyclone, in which the float material is concentrated, and the underflow stream, in which the sink material is concentrated, are used without intermediate pumps as the feed to a set of secondary cyclones. This process is repeated until the desired level of product purity and recovery has been reached. A system having two stages of separation was used to separate the materials whose properties are given in Table II. A product purity of 99.8+ per cent and a recovery of 98.5+ per cent were obtained on those materials. This separation is considerably better than that obtainable by other methods. Higher recoveries and product purity could have been obtained by using additional refining stages had the value of the material warranted further treatment.

**Miscellaneous Applications**

In general, the liquid cyclone is of value in the separation, classification or elimination of solid or liquid materials. Examples of classification have been cited in the coal, phosphate rock and sand industries; and examples of solids separation, in the agricultural industry. The elimination of solids by the liquid cyclone might prove to be a solution to the prevention of stream pollution by sewage and industrial wastes. The cyclone would concentrate the refuse material in a very small volume, thereby giving a readily disposable overflow stream. Solids elimination might also be utilized to sep-

TABLE II.
PROPERTIES OF SEPARATED MATERIALS

| | Sink Material | Float Material |
|---|---|---|
| Composition | 85% | 15% |
| Specific Gravity | 1.270 ± 0.005 | 1.200 ± 0.030 |
| Particle Shape | Concave Disks | Needles |
| Particle Size Range—Microns | 0 to 830 | 0 to 500 |

arate a product material from its mother liquor in crystallization operations and the like.

The use of the liquid cyclone in separating liquid materials of different specific gravities is still in the speculative stage. However, the separation of water-oil mixtures from petroleum wells and similar applications seem worthy of investigation.

**Summary**

The liquid cyclone is a device capable of achieving a high degree of separation, classification or elimination of solids or liquids. It is simple in design, inexpensive to construct, maintain and operate (since no moving parts are involved), self-adjusting in operation and extremely high in capacity. The liquid cyclone has no real disadvantages, merely limitations. When the liquid cyclone will do the job required, alternate methods are little competition for it in cost or operation. For these reasons, interest in the liquid cyclone is increasing exponentially, and it should, before long, be a common sight in a wide variety of industrial processes.

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## RESEARCH MANPOWER

*Continued from Page 2*

1, and about $1.7 billion of this specified for military projects, it would certainly seem that demand has exceeded supply.

According to Dr. Walker, the chief deterrent to rapid expansion of the nation's research potential is the lack of scientific manpower rather than a shortage of dollars or material facilities. A number of recently published statistics support his contention. A questionnaire answered by 41 research organizations revealed that they had already hired as many new men by mid-year as they did in all of 1950. A National Security Resources Board survey of 300 organizations indicated that they had 18,000 jobs for engineers and had been able to fill only half of them.

Dr. James R. Killian, president of Massachusetts Institute of Technology, recently stated that the engineering manpower shortage will become still more acute in the next few years. "Based upon present enrollments, estimates have been made which indicate that in 1954 we will turn out of our engineering schools from 12,000 to 16,000 students. This compares to an output just before World War II of some 20,000 engineers a year. The country's demand for engineers is greatly in excess of what it was before the war. Estimates now place the annual demand around 30,000."

In his statement on page two of this issue, President Van Leer has put his finger on the major cause for the shortage of competent researchers; namely, a lack of young men both intellectually qualified and temperamentally suited to engage in such work. There is relatively little we can do to increase the nation's "brain power," short of selective breeding programs repugnant to a democracy. However, we can seek out those qualified youths who do exist and encourage them to acquire educations which will enable them to make full use of their native talents. This is being done through the National Science Talent Search which now covers a large portion of our country's high schools annually. Dr. W. T. Ziegler of the Station's staff served as chairman of the Georgia Academy of Science committee appointed to judge papers submitted by the state's seniors last year.

There are a number of other things which could go far in ameliorating the research manpower situation. Among them are a draft policy which recognizes the importance of higher scientific education, greater participation by industry in scholarship and fellowship programs, increased emphasis on graduate training for research and better salaries for those engaged in research. Steps to bring each about should be taken immediately lest we find that the enormous productive capacity of our industry is all dressed up with no place to go but around and around the same block.